CRUSADER

SMART Flagship IPR

Presented to:

LTG Paul J. Kern
Military Deputy to the Assistant Secretary of the Army (AL&T)

Presented by:

COL Charles A. Cartwright
PM Crusader

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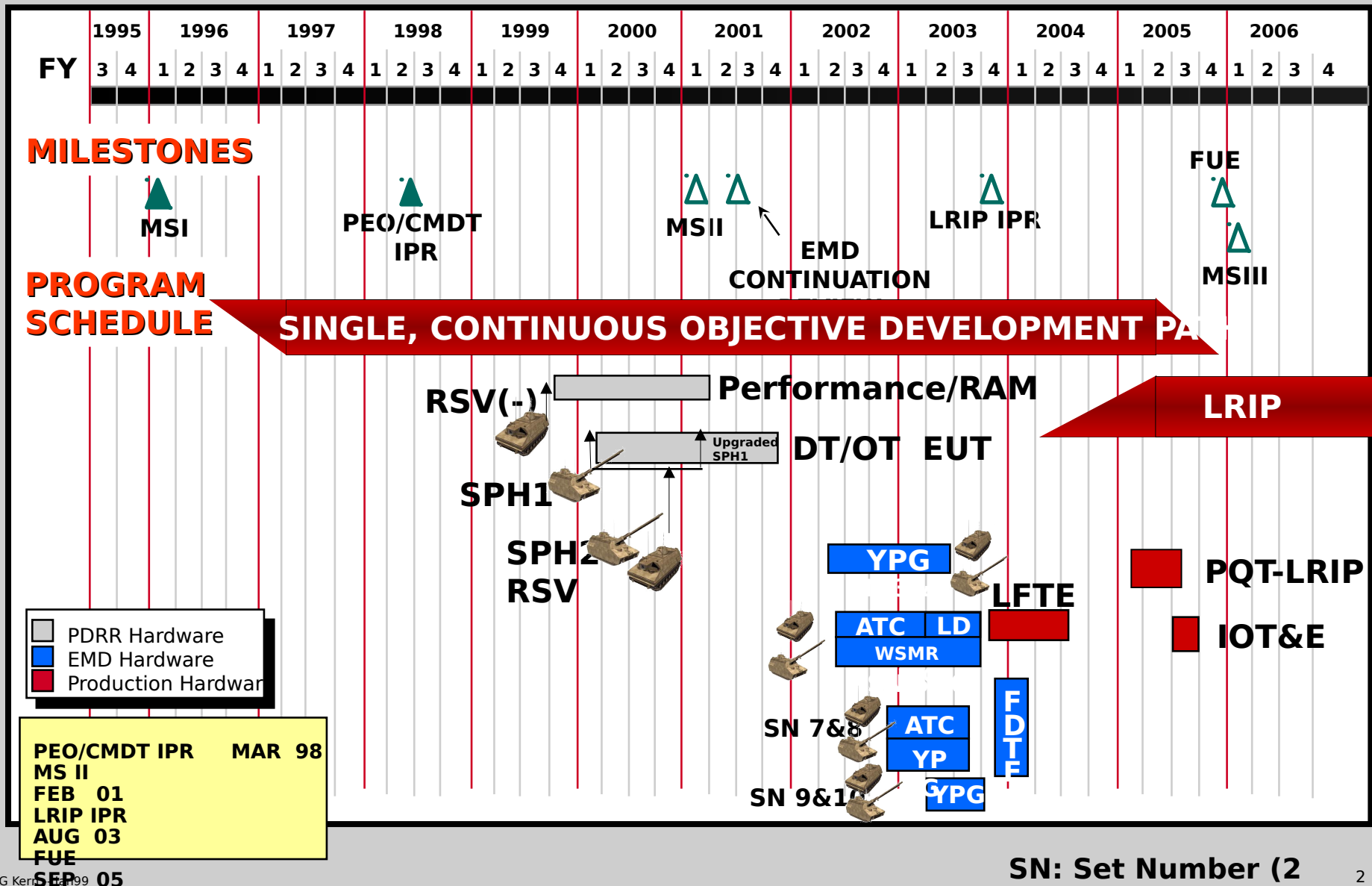fax: (973) 724-4836
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http://www.udlp.com/crusader

26 February 1999

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Program Schedule

Crusader - A System for the 21st Century

Lethal Firepower
- Cooled Cannon for Continuous Fires
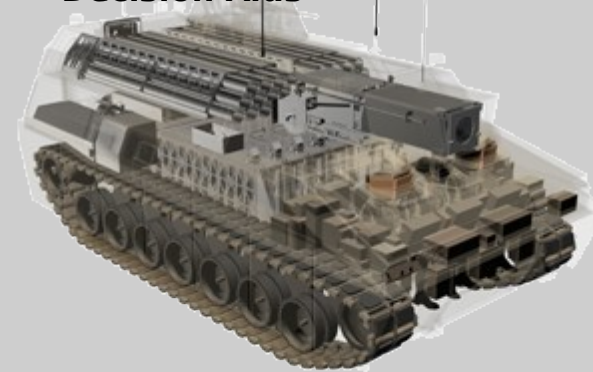- 10-12 Rnds/minute out to 40-50 km
- Enhanced Accuracy with PTS

XM2001

Crew Cockpit Enables Information Dominated Warfare
- Mission Planning
- Situational Awareness
- Decision Aids

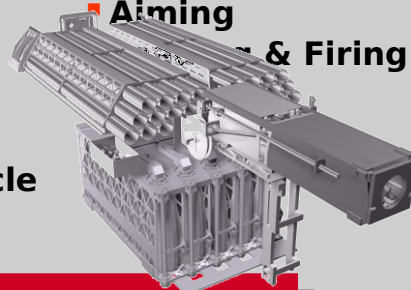**XM2002**

Fully Automated
- Resupply
- Ammunition Handling
- Aiming
- & Firing

Highly Mobile
- 1500 HP to Meet & Exceed M1/M2
- First Drive-by-Wire Ground Combat Vehicle
- Ride Quality Better than M1/M2

Unmatched Survivability
- Separate Crew & Weapon Stations
- Composite Armor
- Ballistic Protection

60% Parts Commonality

Given Crusader's Complexity, We Cannot Succeed w/o M&S

Crusader Modeling and Simulation Players

- SSP includes VV&A plan
- Briefed to Dr. Fallin Sep98
- Signed by Gov't & Industry PM
- Coordinated with SCG members

- Next update of SSP Mar99
  - Expand HLA & Interoperability
  - Update VV&A status
  - Incorporate TRADOC, AMSO, & SARD-DO comments

OPM

User

TEAM CRUSADER

Contractor

SCG

ARL   DOTE   STRICOM

AMSAA   TSM

OPTEC

Products & Support

UDLP   AMSO

DTSE&E   PM   ARD

TECOM   Crusader

Needs & Issues

ARMY M&S Domains

TEMO   RDA   ACR
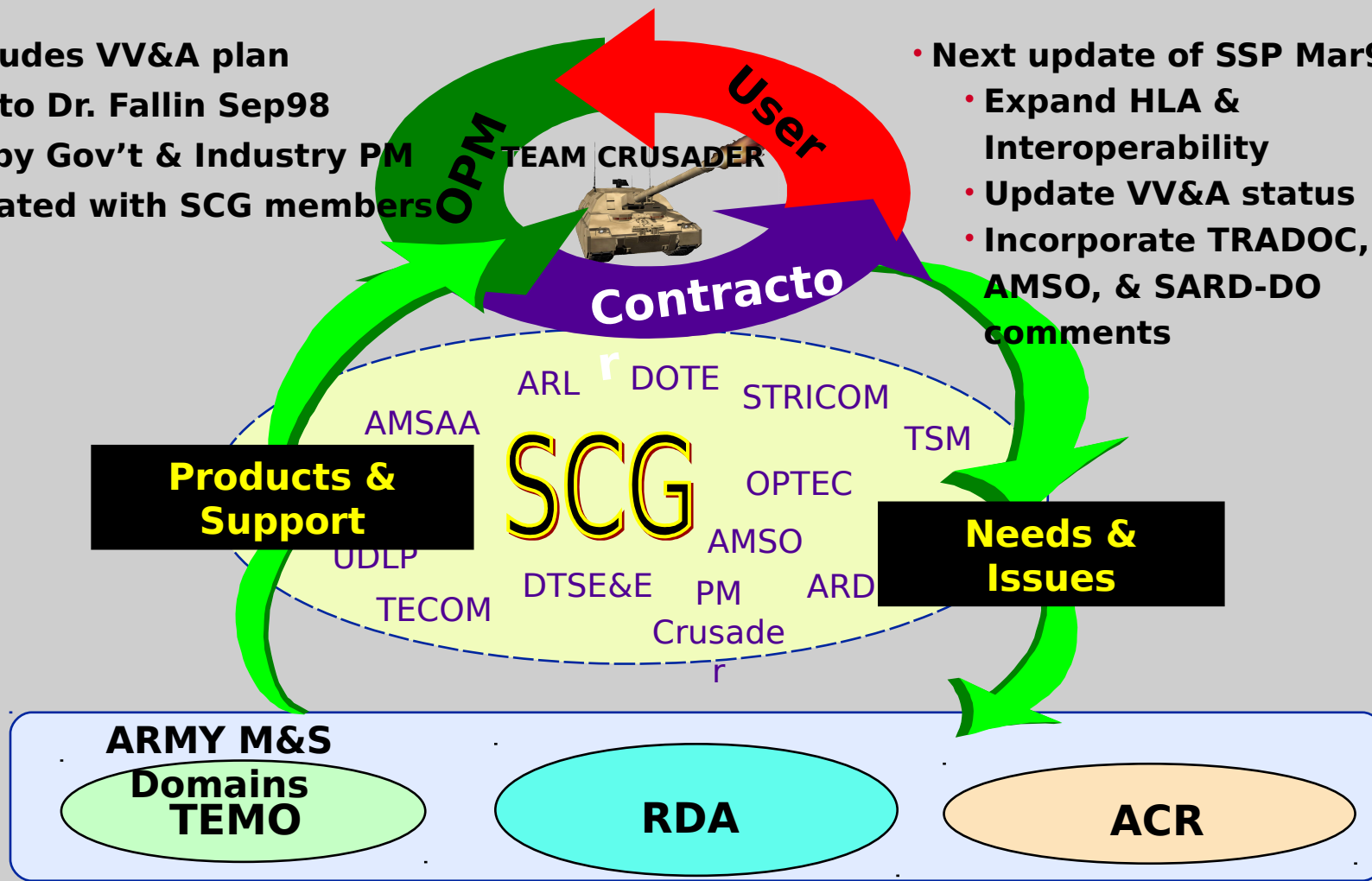
Crusader SSP is a Standard for Other Programs

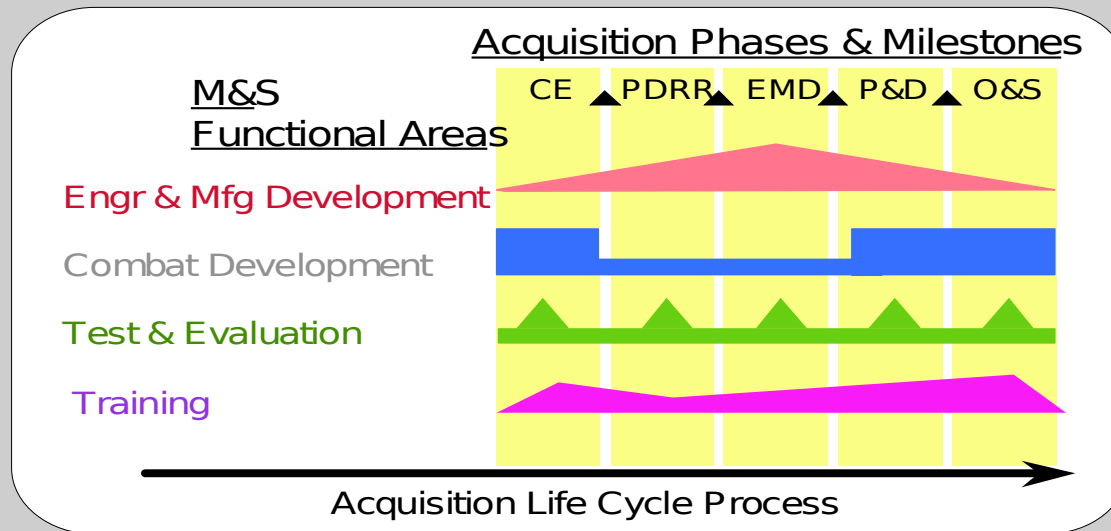# Crusader Use of Existing M&S

No "reinventing the wheel" in Modeling and Simulation activities

System Battlefield effectiveness is modeled with standard Army models such as JANUS

Acquisition Phases & Milestones

M&S Functional Areas

CE ▲ PDRR ▲ EMD ▲ P&D ▲ O&S

Engr & Mfg Development

Combat Development

Test & Evaluation

Training

Acquisition Life Cycle Process

Training devices will use adaptations of Crusader tactical software and models

Engineering Design is accomplished with commercial, off-the-shelf software that is standard throughout industry

e.g. Pro-E, Rational Rose, SafeWorks, Ada, Battlefield Effectiveness, FireSim XXI, ...

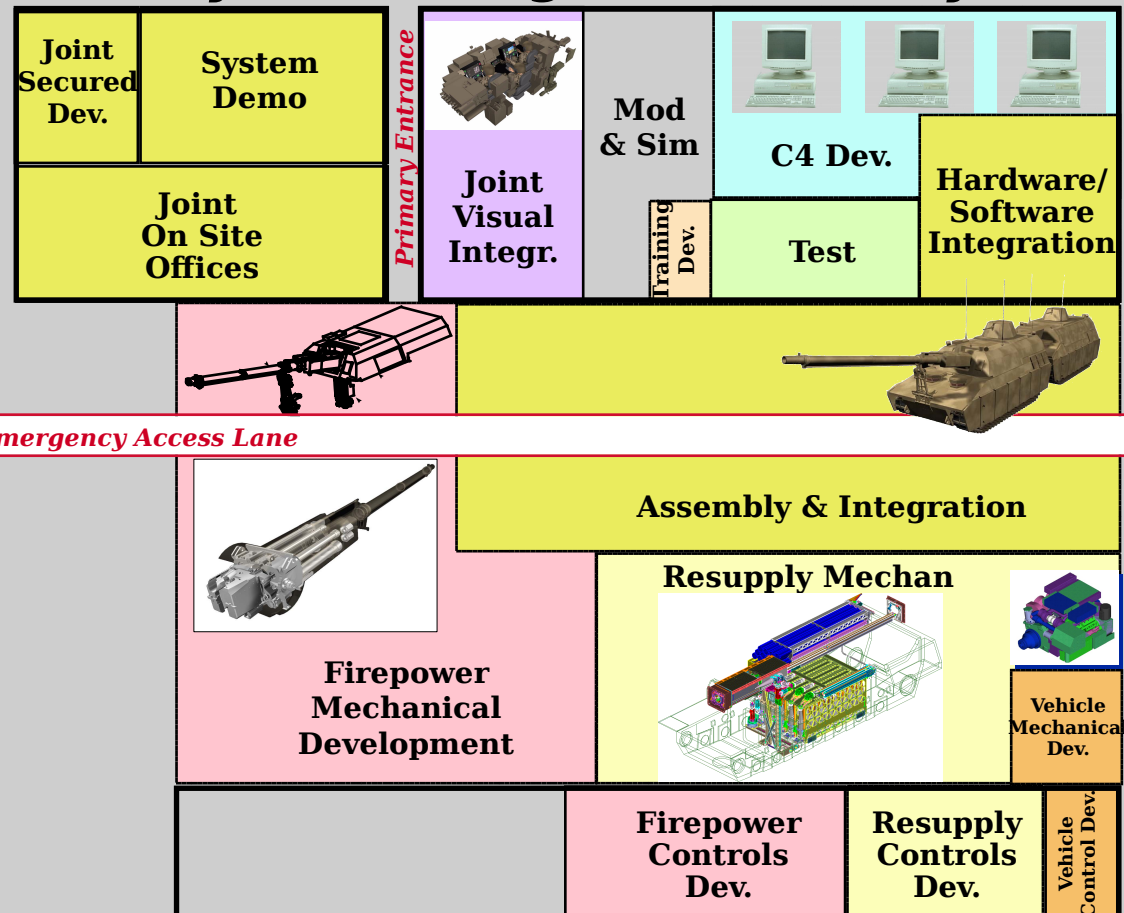## What is Unique is Not the M&S Tools we Use, but HOW we Use them!

System Integration Facility (SIF)

Consolidates M&S development, integration & support within a single facility

System Integration Facility

- ❖ **Full support of M&S development environment**

- ❖ **SIF will continue to support Crusader through production fielding and entire life cycle**

| Joint Secured Dev. | System Demo |
| Joint On Site Offices | |

Primary Entrance

Joint Visual Integr.

Mod & Sim

Training Dev.

C4 Dev.

Test

Hardware/ Software Integration

Emergency Access Lane

Assembly & Integration

Firepower Mechanical Development

Resupply Mechan

Vehicle Mechanical Dev.

Firepower Controls Dev.
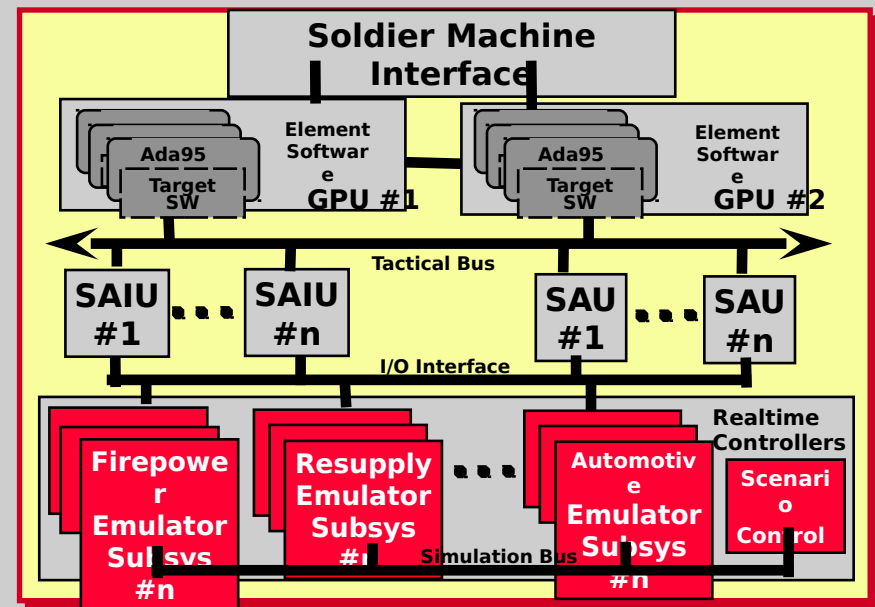
Resupply Controls Dev.

Vehicle Control Dev.

CRUSADER

Integrated Crusader Emulator (ICE)

Complete, dedicated representation of the Crusader system

❖ **Final result of a complete "virtual integration"**
- ◆ **Tactical SW running on target electronics platforms**
- ◆ **Hardware emulators interchangeable with real HW**
- ◆ **Provides reconfigureable man-machine interface**

❖ **The ICE Provides a Platform for:**
- ◆ **End-to-End Digital Simulation of System**
- ◆ **Testing SW / HW upgrades (PIPs)**
- ◆ **Post-deployment maintenance and troubleshooting**
- ◆ **Demonstration of Crusader capabilities and system operation**
- ◆ **Training**

Diagram:
- Soldier Machine Interface
- Ada95 Target SW — Element Software GPU #1
- Ada95 Target SW — Element Software GPU #2
- Tactical Bus
- SAIU #1 ... SAIU #n
- SAU #1 ... SAU #n
- I/O Interface
- Realtime Controllers
- Firepower Emulator Subsys #n
- Resupply Emulator Subsys #n
- Automotive Emulator Subsys #n
- Scenario Control
- Simulation Bus

The functionality and configuration of the ICE will track Crusader through the entire life cycle of the system

Virtual / Visual Prototype

❖ **A realistic visualization of dynamic movements of SPH and RSV models based upon the Master Model**

- ◆ **Merging Mechanical Timelines, Solid Model Animation, and Software Objects**
- ◆ **Software synchronizes and triggers the motion of mechanical components**

❖ **Benefits**

- ◆ **Dynamic space claim verification**
- ◆ **Enhanced communication**
- ◆ **Visualization of mechanical motions and timelines**
- ◆ **Help people understand complex Crusader Operations**
- ◆ **Unify and give interactivity to Crusader Concepts**
- ◆ **Tailored visual information for reuse in customer products.**
- ◆ **Define system behavior and characteristics early**

Rof.avi

Visual Integration Lab

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Out-the-Window Views

Crew Compartment Layout Optimization

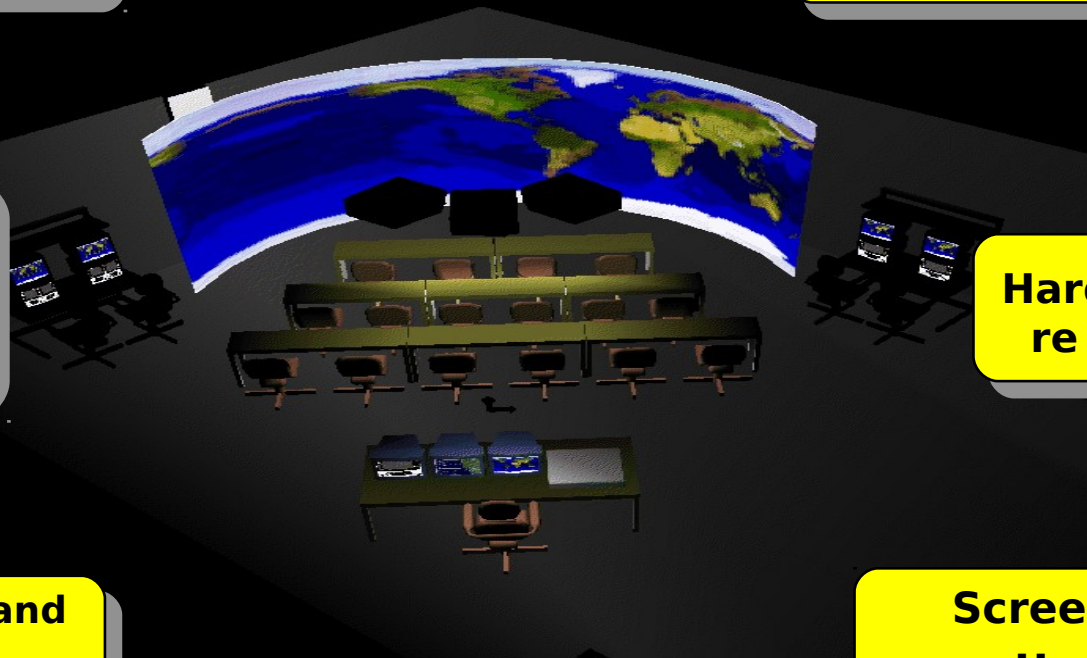**Engineering Synergy through Computer Power and Graphics Fidelity**

Hardware/Software Interactions

Maintenance Tasks and Operations

Screen Design User Jury

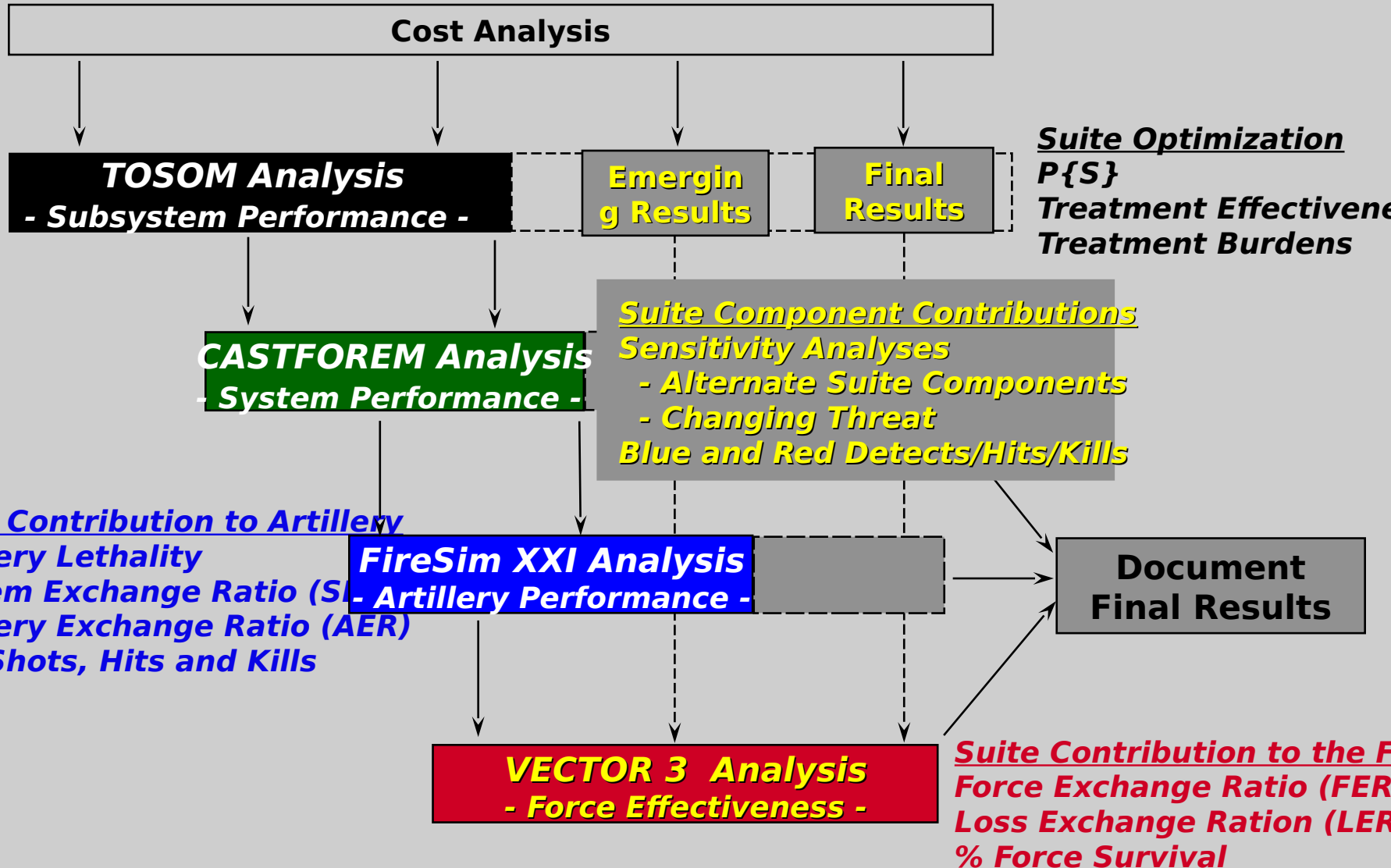**Man-Machine Interface Optimization**

State-of-the-Art Engineering

Software Development

❖ **Dynamic Object Model (DOM) used for verification of software architecture**

❖ **Low Fidelity Models are simulation of inter-CSCI messages (RSV- only)**

- **Provides a model of the rest of the system for a given CSCI's development**
- **Supports System Integration by providing an early look at how the SW fits together**

❖ **Visual Prototype is crew-in-the-loop simulation that provides a "blueprint" of Crusader operations**

❖ **High Fidelity Models are real time emulation of electrical interfaces**

- **Early look at S/W and electrical interfaces**
- **Convenient way to locate interface and interaction problems**
- **Provides the software developer with a realistic view of the hardware**

Survivability

CRUSADER

Cost Analysis

TOSOM Analysis
- Subsystem Performance -

Emerging Results

Final Results

Suite Optimization
P{S}
Treatment Effectiveness
Treatment Burdens

CASTFOREM Analysis
- System Performance -

Suite Component Contributions
Sensitivity Analyses
* - Alternate Suite Components*
* - Changing Threat*
Blue and Red Detects/Hits/Kills

Suite Contribution to Artillery
Artillery Lethality
System Exchange Ratio (SER)
Artillery Exchange Ratio (AER)
# of Shots, Hits and Kills

FireSim XXI Analysis
- Artillery Performance -

Document Final Results

VECTOR 3 Analysis
- Force Effectiveness -

Suite Contribution to the Force
Force Exchange Ratio (FER)
Loss Exchange Ration (LER)
% Force Survival

LTG Kern -- Jan99

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M&S Supports Logistics

Safework
- **Identified interferences in LRU placement**
- **Verified accessibility for 5-95th percentile male soldier**
- **Verified tube removal and roll-in/ roll-out powerpack**

Pro-Engineer
- **Backbone for Safeworks and transportability simulation**
- **Provided drawings for IETM development**

Compass
- **Provided initial level of repair for LRUs**

EDCAS
- **Identified high cost and maintenance drivers**

ARTREARM
- **Verified suitability of current ammunition supply system**
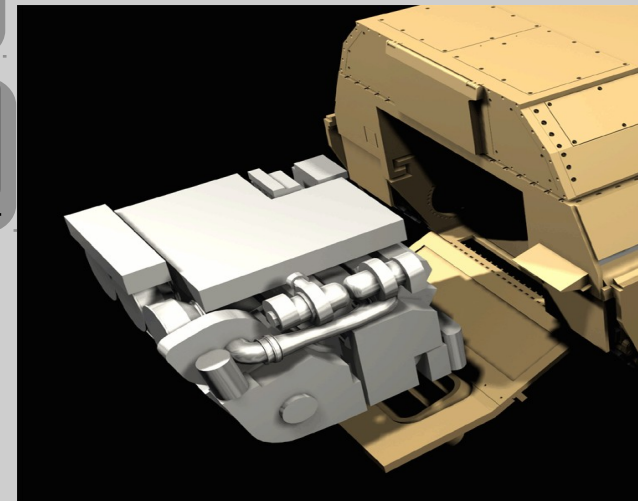
NATO Reference Model
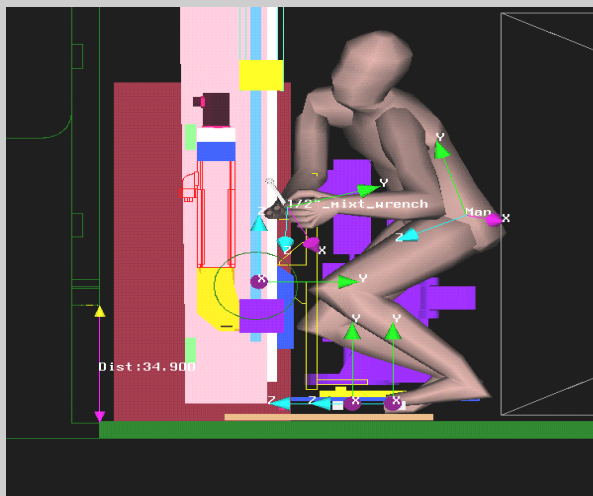- **Verified M88A1 can support Crusader recovery**

eXpress
- **Modeled diagnostic concepts**
- **Identified fault isolation percentages**
- **Identified methods to increase testability effectiveness**

DADS
- **Conducted virtual rail impact tests**
- **Identified lift points for shipping**

TARGET and ALPS
- **Assessed deployability**
- **Evaluated suitability of terrain for travel**

Ownership Cost Reduction by Design

Key Design Principles Enabling Reduced Ownership Costs

Embedded Diagnostics/ Prognostics

System Automation

Embedded Training

Component Commonality

Open Architecture

LRU Modularity

Benefits

- 33% Reduction in Crew
- 12% Reduction in Other Personnel
- 35% Reduction in OPTEMPO
- Lower MTTR
- Lower Maintenance Ratio
- Improved Reliability
- Reduced Spares/Repair Parts Cost
- No Impact of Parts Obsolescence

Facilitates 'Modernization Through Spares' Initiative

The User Community Models
Crusader Effectiveness

DCD @ USAFAS
TRAC (Leavenworth, White Sands)
TSM

Low-Level Models
Games
Artquick
Genesis

Iterative process among all models ensures Crusader unique capabilities (MRSI, ROF, shoot & scoot) are not "lost" but affect battle outcome

High-Level Models
Castforem (Brigade)
FireSimXXI (TAFSM) (Division)
VIC (Corps)
AOM (Deep Battle)

TSM CEP Program
uses Janus 6.88D and FireSimXXI

Efforts are being made to link selected models (FireSimXXI, AOM, Castforem) to automate above

Other Models
• **FARSM Resupply Model**
• **Army Mobility Model**

M & S Tools: J-Link and Fire Support XXI

Exercises Evaluate:

CEP1 (4Q 1996) (Ptr Sim)
- Evaluate Command & Control at battalion level
- Develop / Verify TTPs

CEP2 (3Q 1997)   (Ft. Hood)
CEP1 PLUS:
- Use data link for interface with AFATDS
- Used Direct Support unit at Ft. Hood
- Added fire support node

CEP3 (4Q 1998)   (Ft. Hood)
CEP1 & CEP2 PLUS:
- Evaluate C^2 at battalion, battery, platoon & section level
- Use PC based C^2 centers & workstations
- Use available prototype hardware and software
- Longer scenarios

Future Fires Command & Control CEP (4Q 1999)

➔ **(Battlelab @ Ft. Sill)**
- BN FA TOC   "Information Age", AAN
- Operational architecture, manpower/personnel to meet AAN requirements?
- Mix of MLRS and Crusader
- Assess automation/digital tools
- Evaluate in a synthetic environment
- Result: Validated concept for BN FA TOC of the future
- Future Battlelab CEPS through 2002 will examine brigade through Corps C^2

Increasing Maturity

- •Movement C^2
- •Information throughput
- •Situational awareness
- •Vehicle ammunition status reporting
- •Ammunition resupply (ATP to SPH)
- •Logistics resupply C^2
- •Personnel roles and responsibilities
- •Tactics, techniques & procedures
- •Unit training
- •Unit basic load
- •Survivability tactics
- •Battalion staff organization
- •Streamline of fire mission processing   timeline

EUT (2001)

FDTE(2003)

M&S lets soldiers get involved with the system sooner

Use of M&S in Support of Testing

M&S to Support Test Design

- Selection of Test Conditions
- Sample Size
- Scale Down Test Scenarios
- Aid in selection of Operational Scenarios

M&S to Support Test Preparation

- Check Test Op Orders for timing of events; test objectives are achieved
- Simulate Mission Process for selection of best places to collect data and practice data management and analysis process
- Use Constructive or Virtual Sims to assess tactics and doctrine, train test participants, rehearse mission

M&S to Support Test Limitations

- Safety
- Non Available Assets
- Peacetime Restrictions

M&S to Reduce Test Costs:

- Thin out unnecessary live assets
- Represent interoperability communications load
- Automate human inputs

M&S to Support to Evaluation

- Examine non-tested conditions
- Conduct baseline comparisons

M&S for T&E

Range:
- Gunfire Dynamics
- Trajectory
- Ballistic

Crew Size:
- Crew Module Demonstrator

Transportability:
- Solid dynamics

Rate of Fire:
- Gun Thermal & Structural
- Gunfire Dynamics
- Ammo Handling

Force Effectiveness
- Fire Sim XXI
- VIC
- CASTFOREM

MRSI:
- Ballistic
- Veh. Dynamics
- Gunfire Dynamics

Survivability:
- MUVES S2
- Fire Support XXI
- Top Attack Simulation

MS II Success Criteria

Responsiveness:
- Fire Mission Queue
- Int. & Ext Commo
- Crew Mod Demo

Accuracy:
- CADAM
- Vehicle Dynamics
- Gunfire Dynamics

Resupply:
- ICE

Mobility:
- Engine/Transmission
- Vehicle Dynamics
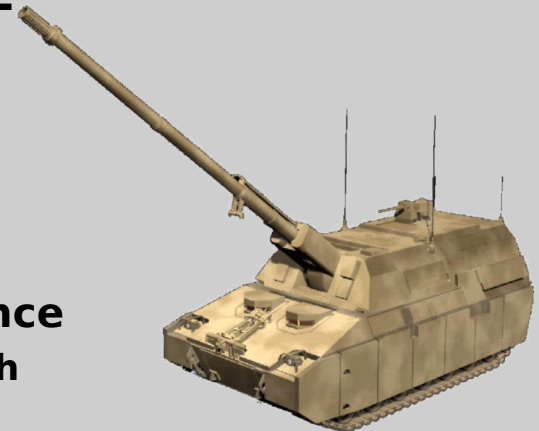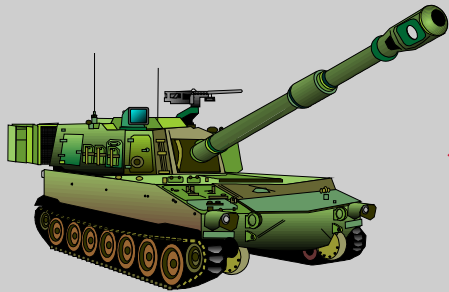- Terrain

M&S Replacing Side-by-Side IOT&E

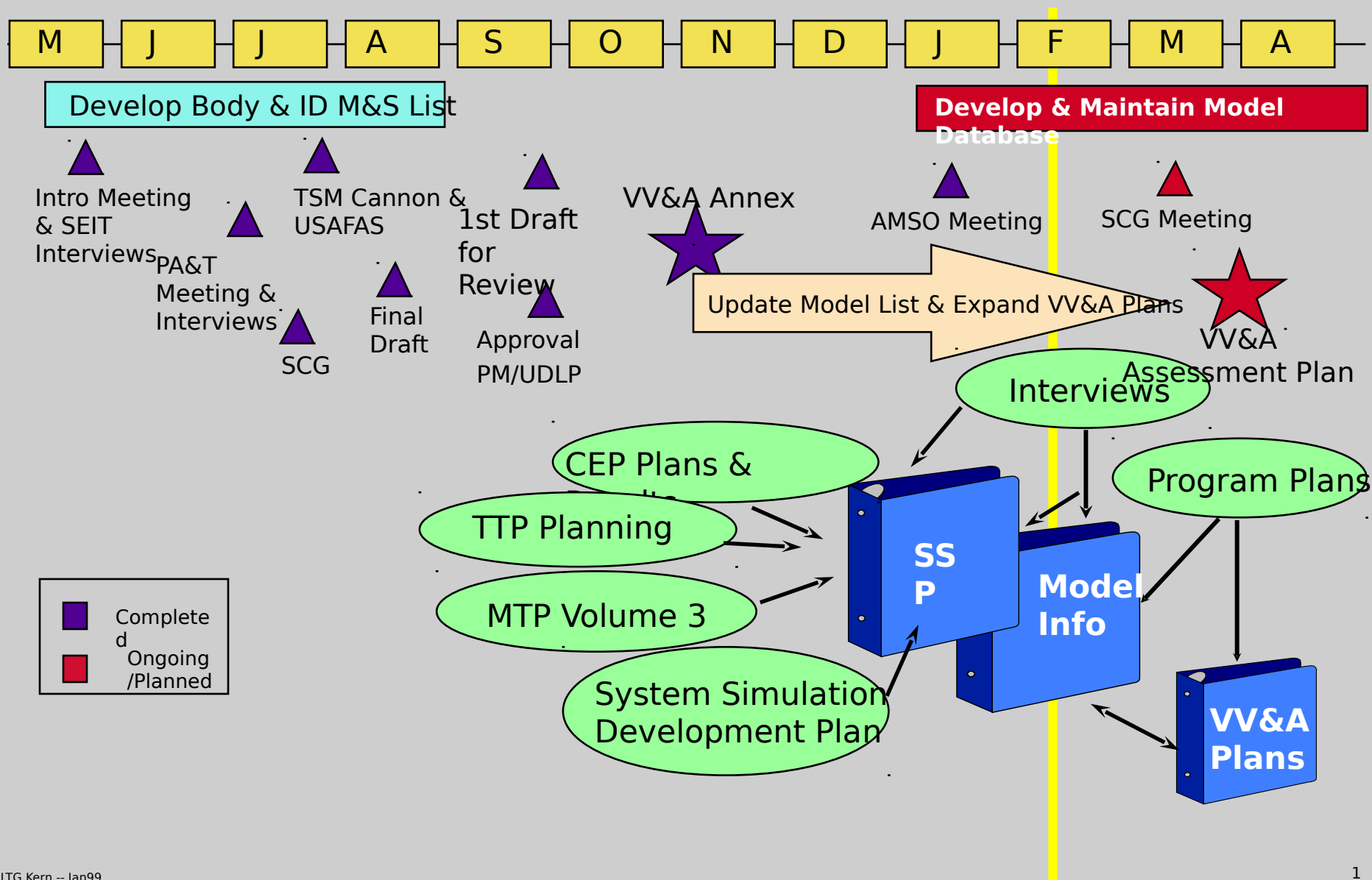- ❖ **DOT&E Wanted Side-by-Side IOT&E**
  - ◆ **Crusader vs. Paladin/FAASV**
  - ◆ **Estimated Additional $10M Effort**
- ❖ **M&S Used to Support 3-Tier IOT&E Evaluation**
  - ◆ **Compare Vehicle Critical Technical Performance**
    - ▪ **Crusader Tested vs. Paladin/FAASV Data**
  - ◆ **Compare Battalion Staff Performance**
    - ▪ **Perform as CPX, Using M&S to Flesh Out Vehicles**
    - ▪ **Test Paladin Bn Staff Prior to Crusader Training**
    - ▪ **Train Paladin Bn to Crusader Standards**
    - ▪ **Retest in Crusader Configuration**
  - ◆ **Compare Force Effectiveness**
    - ▪ **Force Models to Provide Comparative Force Effectiveness**
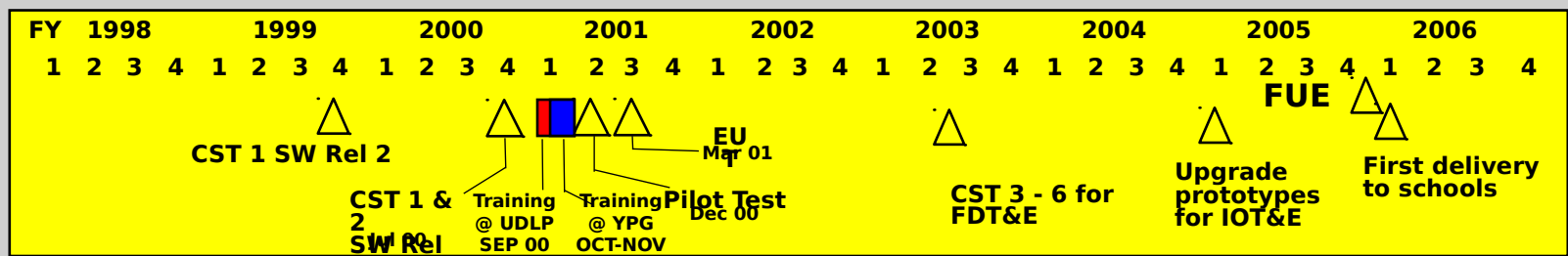   - ▪ **Same Models as Used in AOA for Continuity**

VV&A Roadmap

❖ **CST has been used in:**

- ❖ **Hardware redesign**
- ❖ **Soldier in the loop evaluation**
- ❖ **LSAR data evaluation**
- ❖ **Hardware layout**

❖ **CST will be used to:**

- ❖ **Initial evaluations of tactical software releases**
- ❖ **Integrate software with hardware**
- ❖ **Continue soldier in the loop design and MANPRINT evaluations**

❖ **Crew Station Trainer (CST) and embedded training will be HLA compliant**

FY	1998	1999	2000	2001	2002	2003	2004	2005	2006
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4

FUE

CST 1 SW Rel 2

CST 1 & 2 SW Rel

Training @ UDLP SEP 00

Training @ YPG OCT-NOV

Pilot Test Dec 00

EUT Mar 01

CST 3 - 6 for FDT&E

Upgrade prototypes for IOT&E
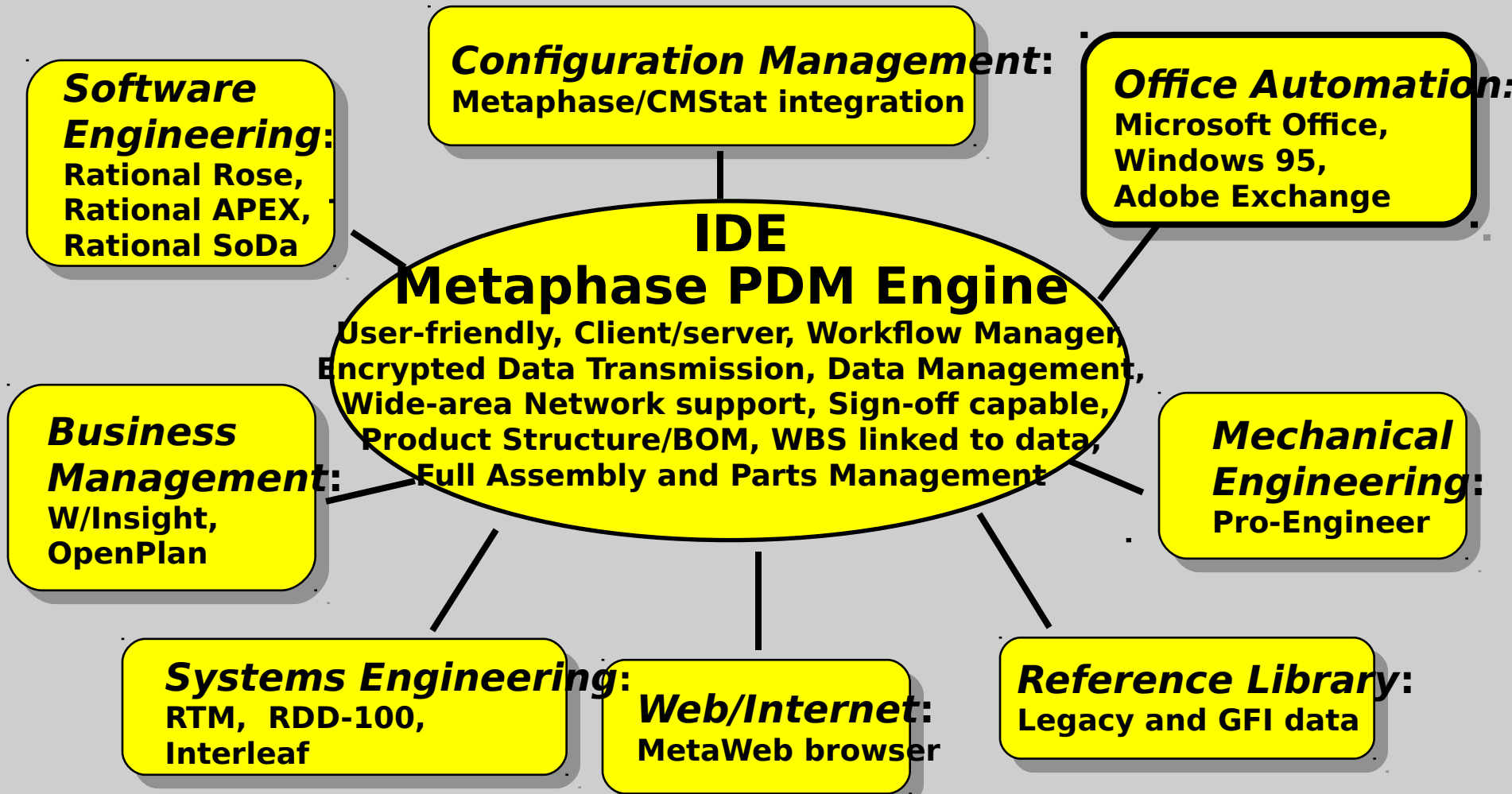
First delivery to schools

M&S in Crusader Production

- ❖ **In Production Crusader will be using Deneb QUEST for Modeling and Simulation**
  - ✦ **The QUeueing Event Simulation Tool, QUEST, is an off-the-shelf production facility model which combines detailed physical system properties with interactive 3D graphics**
- ❖ **Deneb Robotics, Inc. also has other off-the-shelf Manufacturing and Simulation tools which may be used including:**
  - ✦ **IGRIP -   tool for designing, evaluating and off-line programming robotic workcells**
  - ✦ **Virtual NC - simulation-based interactive engineering tool for visualizing and analyzing the functionality of a machine tool, its CNC controller and the material removal process to optimize machining**
  - ✦ **Deneb/Assembly - assembly planning and process documentation tool**

Paperless PMO

CRUSADER

Configuration Management:
Metaphase/CMStat integration

Software Engineering:
Rational Rose,
Rational APEX,
Rational SoDa

Office Automation:
Microsoft Office,
Windows 95,
Adobe Exchange

**IDE
Metaphase PDM Engine**
User-friendly, Client/server, Workflow Manager,
Encrypted Data Transmission, Data Management,
Wide-area Network support, Sign-off capable,
Product Structure/BOM, WBS linked to data,
Full Assembly and Parts Management

Business Management:
W/Insight,
OpenPlan

Mechanical Engineering:
Pro-Engineer

Systems Engineering:
RTM, RDD-100,
Interleaf

Web/Internet:
MetaWeb browser

Reference Library:
Legacy and GFI data

IDE available for standardization throughout DA and DoD

Summary

SMART Conference of 27-29 January 1999

- Collaboration Between User, Builder (Industry) and Trainer Will Occur Concurrently Through Integrated Digital Environments (IDE) in Which Data is Transferred Seamlessly across COTS Tools and Applications" . . . LTG Kern's Briefing
  - *This Has Long Been a Key Tenant of Crusader Development Strategy!*
- "Provide Early and Continuous Training Context Assess Impact of TTP and Doctrine on Design Concepts" . . . LTG Kern's Briefing
  - *Crusader's active involvement in CEP exercises supports OCD development and put the soldier in the loop long before the first prototype was built.*
- DoD Reg 5000.2-R "…modeling and simulations shall be applied throughout the system life cycle …design and engineering, test planning, results predictions, manufacturing, and logistics support" . . . LTG Campbell's Briefing
  - *Crusader is applying M&S throughout its lifecycle - aggressively and pervasively*
- "How do you make it easier for users to collaborate with designers,engineers, etc.? Provide desk top interactive visual representation (virtual prototypes). Especially important during early stages when concepts are still being shaped" . . . Ms. Purdy's Briefing
  - *The work being done in Crusader's System Integration Facility and Visual Integration Lab are outstanding examples of virtual prototyping in action.*

There is a Reason Crusader is a "Flagship Program " for SMART
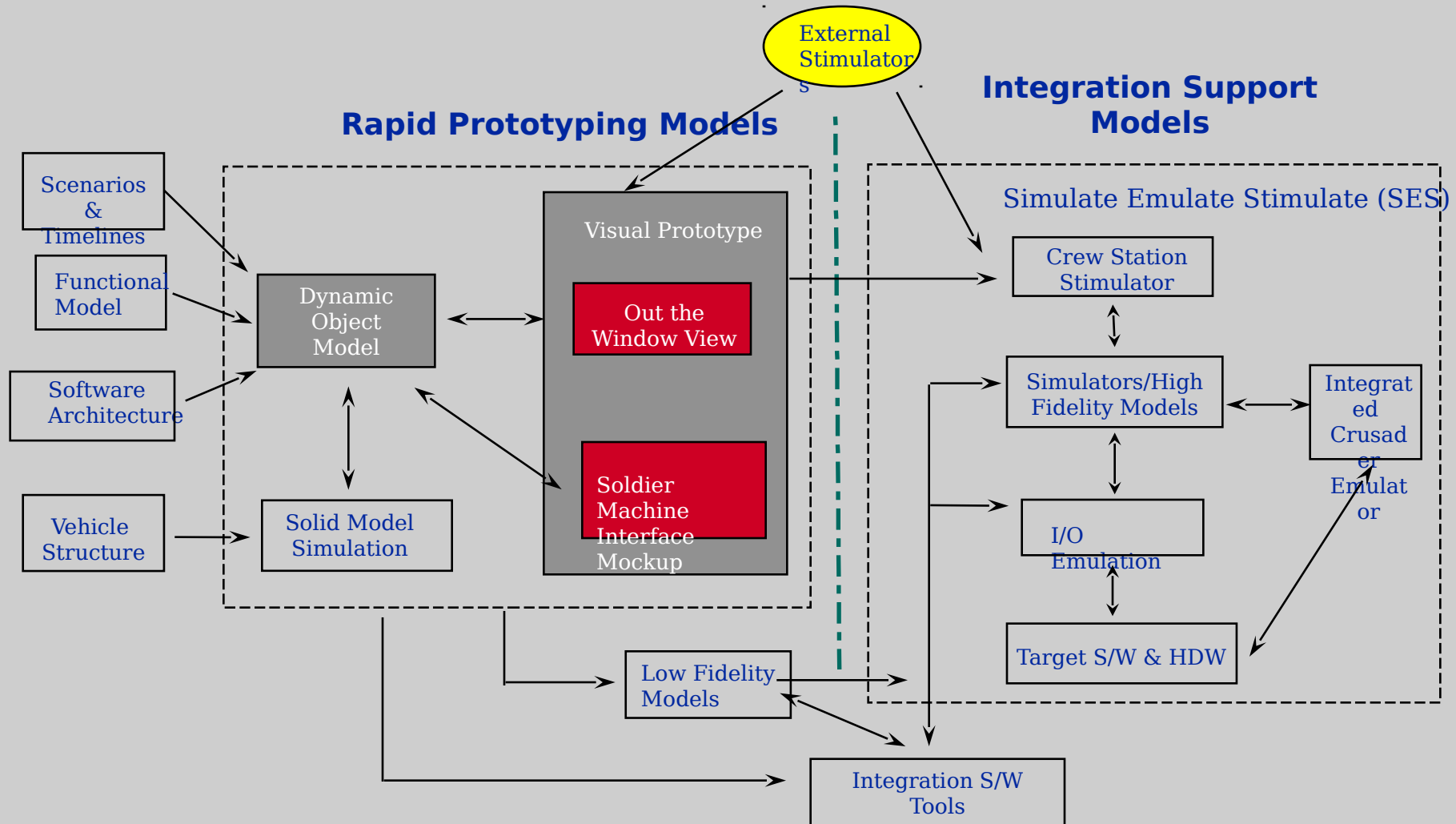
Backups

VV&A Model List/Database

Model Name	Model Purpose	Description	Model Proponent	M&S Functional Area	M&S Language	M&S Developer (POC/Phone/Email)	Development Status	Security Classification (for Both the Code & Input Data)	Documentation (Title/Date/Author(s)/ Distribution, etc.)	Use of Results (Do Results Feed other M&S? List of M&S)	Input Data Required and Source of Data	Model Limitations/ Assumptions	M&S Hardware Requirements (min)	M&S Fidelity
Green -OPTEC	Blue - UDLP- PDRR	Red - UDLP- General	Black - Unknown											
CONPRESS	Predict muzzle velocity	Constant breech pressure calculations to determine muzzle velocity or charge mass. CONPRESS is used to predict muzzle velocity or to determine charge mass and chamber pressure which would result in either a specified muzzle velocity or optimal velocity.	BRL											
Crew Chief	Human Factors Engineering	CAD based tool for evaluation of maintenance interface with user. Run in Unix environment with SDRC I-deas	USAF, U of Dayton											
CREWCUT	Crew workload and performance analysis	Integrates workload estimation algorithm, based on task analysis data, into a dynamic human performance simulation in such a way that the performance consequences of excessive workload can be observed and quantified.	ARL/HRED			Mr. John Lockett 410-278-5875								
Crusader ATD Crew Module	Soldier information	The simulation is for analytic and demonstration purposes and is deterministic in nature. All operator tasks on the critical path for completion of an indirect fire mission appear in real time on the prototype interface. The simulator creates events fro	UDLP, ASD			Mr. Rod Bradenburg 612-572-6240								
Crusader Thermal Model for Crew Compartment	Air Distribution System Optimization	Predicts the temperatures and air velocities in the crew compartment and allows for optimization of the air distribution system. Besides optimization, the model also predicts whether or not the requirements of MIL STD 1472 will be met.	CECOM	Eng Dev/T&E		Neal Blackwell/703-704-3899, DSN 654/nblackwell@belvoir.army.mil/ CECOM/Environment at Systems Branch at Fort Belvoir, VA/Alt Mike Deutsch	Developed and Accredited for other programs but not for Crusader. Validated with data from other programs U				Design Geometry, Cooling rates			High , Computational Fluid Dynamics
CSAL	Virtual Prototyping	Combat Systems Analysis Lab, CSAL. The purpose of CSAL is to develop, analyze, test, and validate system requirements, concepts and capabilities. CSAL is a real-time, networked, visual simulation laboratory for virtual prototyping, capable of networkin	UDLP/GSD											
CTH	Shock wave propagation	CTH is a computer program that is designed to analyze a wide variety of shock wave propagation and material motion phenomena. CTH employs the finite-difference analogs of the Lagrangian equations of momentum and energy conservation with continuous rezoni	Sandia Laboratories	Eng Design		Sandia Corp, Eugene Hertel	In use 10 years	FOUO	User' Manual Version 1.020, Sandia Nat'l Lab, SAND88-0523, 1988	Threat Induced damage predictions; armor design, ballistic shock models, muzzle blast	Target description, Armor description,threat information,Materials Properties			High
DADS	General Mechanical Dynamics Simulations	DADS is a set of general purpose analytical computer programs (which are deterministic in nature) that are used to analyze the motion of real world mechanical systems. The DADS program (in conjunction with the TRACK SUPERELEMENT module) allows three dime	CADSI											
DYNA2D/DYNA3D	Terminal Ballistics		LLNL	Eng Dev/T&E	Unix/Fortran	Dr. John O. Hallquist, Robert G. Whirley, LLNL	In use for 20 years		User's Manual UCRL-MA-107254 Rev1, Nov 1993	Threat induced damage predictions; structural design	Target Description; Armor description, Threat information; Materials Properties			High
DYNACODE-G/P	3D Gun dynamics simulation	Models the dynamics of a gun system during firing. This 3D dynamic simulation includes the effects of gun tube, projectile, and support systems flexibility and such time and motion dependent loads as interior ballistics and projectile/bore interface forc	S&D Dynamics, Inc. Boca Raton, FL.											
Dynaxx	Structural Analysis	Linear and nonlinear dynamic structural analysis of hardware. Strength is nonlinear explicit dynamics analysis including strong surface contact capability. It has been used heavily in crash and projectile penetration studies.	Multiple Vendors											
EBS	Model systemaccuracy	Models the systemaccuracy error budget for a Howitzer. Contains a large database of accuracy information for four families of projectiles.	UDLP/ASD											
ELAN+	Force on Force Analysis	Extended LANchester Plus, Elan+ is a medium resolution analytical tool that can be run in either stochastic or deterministic mode. TATU is a terrain data preprocessor for Elan+ which calculates line of sight and displays data information including vegeta	TRADOC Analysis Command - White Sands											
ENVISM	Electronic Warfare Countermeasures Effectiveness	A generic engineering weapons model with engagement visualization capability designed to analyze and evaluate few-on-few effectiveness of electronic warfare countermeasures. It analyzes the impact of threat weapon intercept, detection and classification	ARL/SLAD			Joe Herman 505-678-8668								
EPIC	Shock wave propagation	Elastic-Plastic Impact Computations. EPIC is a computer program that is designed to analyze a wide variety of shock wave propagation and material motion phenomena. EPIC employs the finite-difference analogs of the Lagrangian equations of momentum and e	Directorate, Wright Laboratory, Eglin Air Force			GR Johnson, Alliant Tech, 60 0Second St, Hopkins, MN 55343	10 years of development and use	FOUO, Exports Control	Tech Systems, March 1996 ," User Instructions for the 1996 Version of the	Vulnerability Penetration Models	Target Description, Armor Description, Threat Information, Materials Properties			High Fidelity

Modeling & Simulation Approach

Rapid Prototyping Models

Integration Support Models

External Stimulators

Simulate Emulate Stimulate (SES)

Scenarios & Timelines

Functional Model

Software Architecture

Vehicle Structure

Dynamic Object Model

Solid Model Simulation

Visual Prototype

Out the Window View

Soldier Machine Interface Mockup

Crew Station Stimulator

Simulators/High Fidelity Models

Integrated Crusader Emulator

I/O Emulation

Target S/W & HDW

Low Fidelity Models

Integration S/W Tools

Concept Development **Preliminary Design** **Detailed Design** **Fabrication and T**

Crusader Use of CAIV To Reduce TOC

❖ Key Tenets of Crusader CAIV Strategy:

- Enlargement of the trade space through the identification of only a small set of key performance parameters
- Identification of the specific elements driving life cycle costs
- Creation of multifunctional teams (to include the user) focused on a common purpose
- Cost Targets:
  - Cost objectives must be managed in the same way as other program requirements.
  - PDRR contract incorporates cost targets for both production and O&S.
- O&S Cost Reduction: Third and highest priority goal in PDRR contract is "Minimize Life Cycle Costs"
  - Lower Development and Production Costs are secondary to overall LCC
  - LCCs are primarily O&S Costs
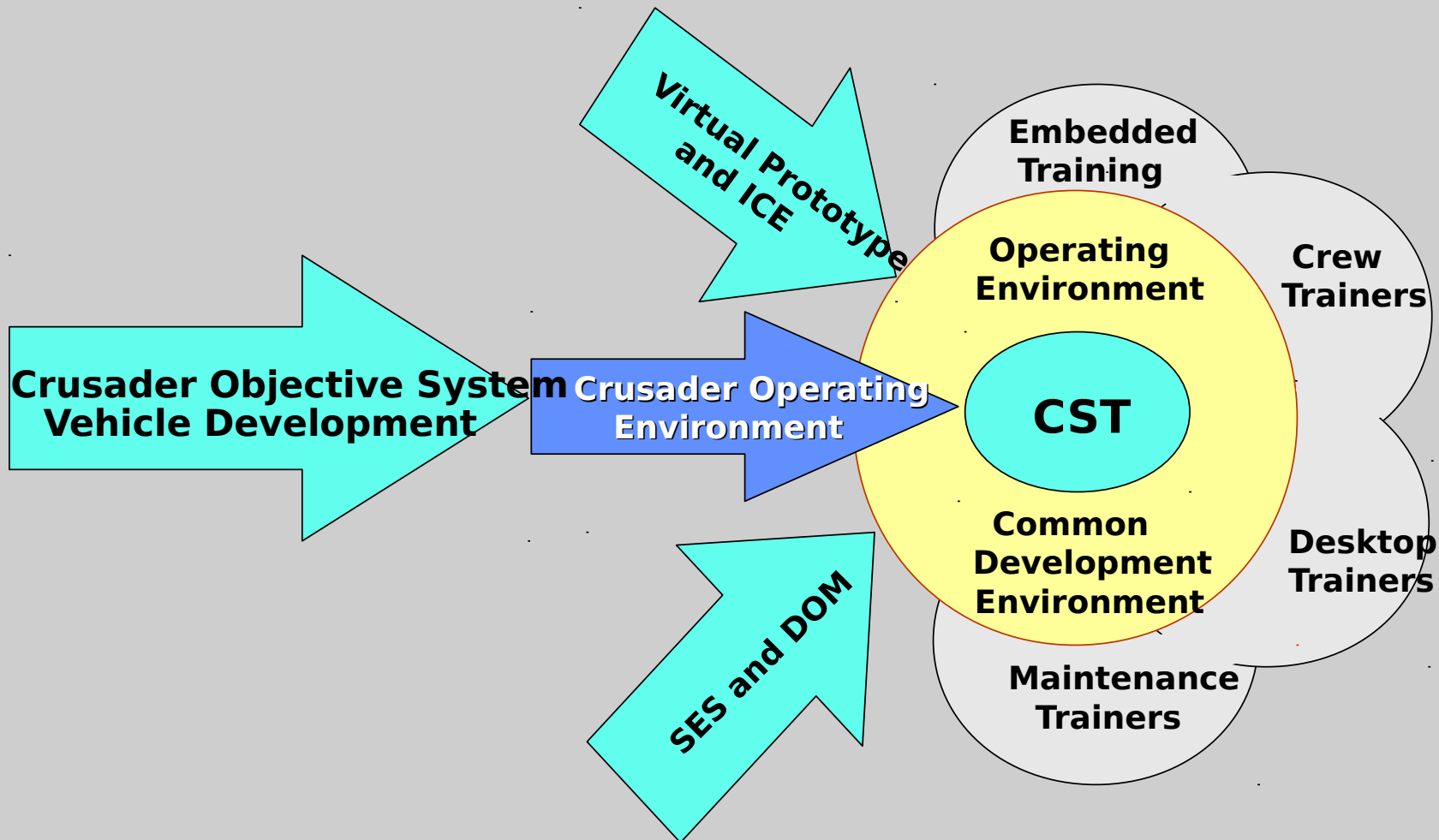
Crusader Use of CAIV To Reduce TOC

❖ Key Tenets of Crusader CAIV Strategy (continued):

- Metrics Employed
    - Unit cost "glide path"
    - O&S cost is monitored through Technical Performance Measures (TPM)
    - Cost-risk assessment
- Incentives -Crusader CAIV process employs a two tier incentive program
    - To contractor through the use of award fee
    - To individuals via cash awards for the identification of cost reduction initiatives
- Cost-Performance Trades
    - Crusader process is innovative in generally stipulating that cost and performance requirements will carry equal weight.
    - Trade studies performed since 1994 have resulted in significant cost reduction/avoidance.
- Other Crusader CAIV Attributes:
    - *Cost Reduction Initiatives*
    - *Training Program*
    - *Plans/Manuals/Handbook*
    - *Management Emphasis*
    - *User Participation*

Digital Mapping

- ❖ **Crusader is participating in First Digitized Division (FDD) Panel which is looking at Digital Mapping**
  - ✦ **First Digitized Division (FDD) will use a new National Imagery and Mapping Agency (NIMA) product called Foundation Feature Data (FFD)**
  - ✦ **In the future, the entire Army will standardize on FFD**

- ❖ **Crusader participates in the Weapon System Technical Architecture Working Group (WSTAWG)**
  - ✦ **A major WSTAWG concern is Map Data Loading Standards**
  - ✦ **This is the means by which NIMA will provide digitized maps to weapons platforms, both aircraft and ground vehicles**

Crusader Simulation Support to Training

Crusader Objective System Vehicle Development

Virtual Prototype and ICE

Crusader Operating Environment

SES and DOM

CST

Operating Environment

Common Development Environment

Embedded Training

Crew Trainers

Desktop Trainers

Maintenance Trainers

Crusader Design Engineering Models Aid in Training Development Initiatives

Total Ownership Cost (TOC) and Return on Investment (ROI)

- ❖ **TOC is tracked by Ownership Cost Working Group (OCWG)**
  - ✦ **OPM, UDLP, TSM-Cannon Members**
  - ✦ **DCSLOG Participation as required**
- ❖ **Models used include EDCAS (Engineering Design Cost Analysis Systems) and PRICE- H**
  - ✦ **PRICE-H being used to cost EMD program**
  - ✦ **EDCAS estimates O&S cost**
- ❖ **Current M&S cost for PDRR difficult to capture - was embedded in PDT costs**
- ❖ **We are currently looking at techniques/methods to capture M&S cost in EMD contract using WBS, and Open Plan**

> **Total Ownership Costs Minimized through use of M&S**
>
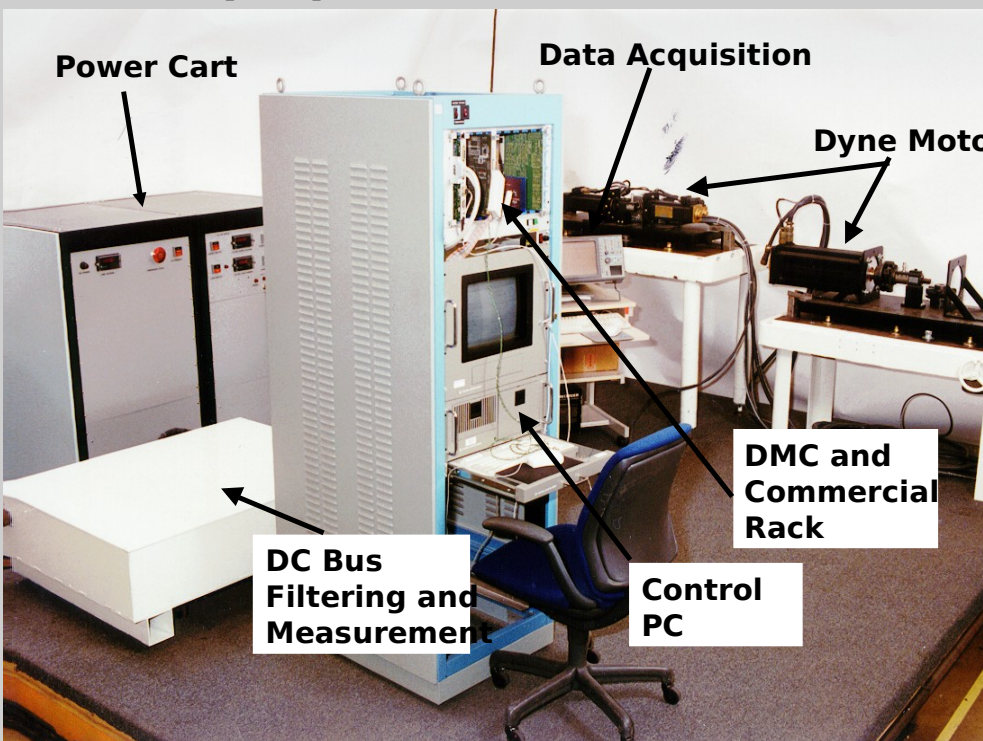> **Savings will be accurately captured in EMD**

Software Reuse

- ❖ **EBC - Embedded Battle Command**

- ❖ **AFATDS Communications Stack**

- ❖ **NATO Artillery Ballistic Kernel**

- ❖ **Real Time Common Operating Environment**

- ❖ **NIMA digital map data bases**

Logistics M&S Tools

* **Virtual operator and task simulations to anticipate anthropometric constraints or interferences with design (SAFEWORK, Pro-Engineer)**

* **Level of Repair Analysis (COMPASS)**

* **Comparative, economic and maintenance high driver analyses (EDCAS)**

* **Identification of diagnostics LRU candidates through dependency modeling (eXpress)**

* **Transportability modeling by MTMCTEA for rail impact simulation , modal fits, lift (DADS, Pro-engineer, Pro-mechanical)**

* **Deployability analyses by MTMCTEA (TARGET, AALPS)**

* **Ammo re-supply impacts analyses (ARTREARM, FASTALS)**

* **Towing analysis of M88A1 for CRUSADER (NATO Reference Model)**

Crusader T&E Integration

- ❖ **M&S is being used where feasible right now**
  - ◆ **Software testing uses M&S**
  - ◆ **Survivability has no alternative: Must use M&S supported by test data**
- ❖ **PM is committed to ensuring SSP is followed - test plan preparers must list M&S used**
  - ◆ **esters and evaluators are part of CG**
  - ◆ **We will work with contractor, User nd T&E community to ensure ptimal integration of M&S into our est strategy**

Power Cart

Data Acquisition

Dyne Motors

DMC and Commercial Rack

Control PC

DC Bus Filtering and Measurement

Models and Tactical HW & SW Relationship

Product Design ➡

1
Workstation
- LoFi Sim
- LoFi Sim
- LoFi Sim
- LoFi Sim

Migrate to Target CPU →

2
Target CPU
- LoFi Sim
- LoFi Sim
- Tgt SW
- LoFi Sim

Incrementally Integrate I/O Emulators

3
Target Electronics
- HiFi Sim
- LoFi Sim
- LoFi Sim
- HiFi Sim
- HiFi Sim
- Tgt SW
- LoFi Sim
- HiFi Sim
- External Stimulators

Incrementally Replace Emulators with Target HW

Upgrade of Functionality

4
Target Electronics
- Target HW
- LoFi Sim
- LoFi Sim
- HiFi Sim
- Target HW
- Tgt SW
- Tgt SW
- HiFi Sim
- External Stimulators

5
Target Electronics & SW
- Target HW
- Target HW
- Target HW
- Target HW

Integrated Product ⬅

Mechanical Integration